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RACT Compliance Guidance for Carbon Adsorbers on Perchloroethylene Drycleaners

PEDCo-Environmental, Inc., Arlington, TX

Prepared for

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RACT requirements for perchloroethylene (perc) drycleaners require that the owner or operator vent the dryer exhaust through a carbon adsorption system or equally effective control device and emit no more than 110 ppm of VOC from the control system. A recent inventory of drycleaning establishments indicates that approximately 10,000 facilities are located in nonattainment areas and must comply with this RACT requirement. Because emission testing of each source would be a formidable task for federal, state, and local EPA personnel, a compliance documentation method that would reduce enforcement effort is needed. This report provides a compilation of control equipment manufacturers' recommendations of combinations of adsorbers and perc drycleaning equipment to comply with RACT regulations. The recommended combinations, however, may have to be adjusted based on source testing of the various configurations.

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SECTION 1

INTRODUCTION

BACKGROUND

The Clean Air Act Amendments (CAAA) of 1977 required each state to report the status of compliance with National Ambient Air Quality Standards (NAAQS) to the U.S. Environmental Protection Agency (EPA). Attainment and nonattainment areas in each state with regard to the control of major pollutants were listed in the Federal Register on March 3, 1978. According to the 1977 CAAA, nonattainment areas must achieve compliance with NAAQS by December 31, 1982, with some possible extensions to 1987.

In December 1978, a Control Techniques Guideline (CTG)[1] was published for control of volatile organic compounds (VOC) from perchloroethylene (perc) drycleaning systems. Those industries in areas where standards covering a particular pollutant are not being met will be required to apply Reasonably Available Control Technology (RACT), which is discussed in the CTG.

On or before January 1, 1980, all states are required to submit to the EPA proposed revisions of the State Implementation Plan (SIP) reflecting RACT for perc drycleaning systems. Promulgation of the regulations is required by July 1, 1980. The new regulations will involve state and local agencies with an industry that to date has received little or no enforcement effort. Previous state regulations pertaining to organic solvents, specifically Rule 66 of the Air Pollution Control District, County of Los Angeles, California, and Part 205 of the New York City Metropolitan Area Regulations, Area Regulations, have always exempted perc from emission limitations. Part 212 of the New York City Metropolitan Area Regulations does provide some limitations to perc emissions from drycleaning facilities.

PURPOSE AND SCOPE OF REPORT

A recent inventory of drycleaning establishments in the United States was compiled from the 1976 County Business Patterns publication of the Bureau of Census. This inventory indicated a total of 19,738 drycleaning facilities using perc, categorized in three industry sectors as follows: 5,179 in

coin-operated facilities; 14,366 in commercial facilities; and 193 in industrial facilities. Percentages of establishments located in nonattainment areas are as follows: coin-operated, 48 percent; commercial, 66 percent; and industrial, 62 percent. The total 1979 perc emissions from all perc drycleaning plants is estimated to be 158,000 Mg (174,000 tons) or 0.9 percent of total VOC emissions from stationary sources. Although the percentage of total nationwide VOC emissions is small, perc drycleaning systems constitute a significant source of VOC emissions in the urban areas.

Model regulations based on the CTG document were issued in September 1979. These model regulations are guidelines to be used by the states in performing revisions of SIP's to be submitted in July 1980. The regulations apply to all perc drycleaning systems in the three industry sectors. They specify that the owner or operator must vent the dryer exhaust through a carbon adsorption system or equally effective control device and emit no more than 100 parts per million (ppm) of VOC from the control system; repair all components leaking liquid perc; and reduce VOC content of residues from diatomaceous earth filters, solvent stills, and cartridge filters prior to disposal. Certain facilities are exempt from the provisions pertaining to carbon adsorption and the associated 100-ppm emission limit; these include coin-operated facilities and other systems where space limitations prevent the installation of a carbon adsorber and/or where steam required for desorption of the carbon bed is not available. Compliance with the 100 ppm emission limit will be determined by EPA Test Method 23 outlined in an EPA Guideline Series document,[2] or by verification that equipment demonstrated to be adequate to meet the 100-ppm emission limit has been properly installed, operated, and maintained. Existing perc drycleaning systems in nonattainment areas are required to achieve compliance with the 100-ppm emission limit by January 1, 1982.

Problems may arise in the enforcement of this regulation by state and local agencies because of the large number of sources. Testing of approximately 10,000 sources would be an awesome task for Federal, state, and local EPA personnel. Moreover, the aggregate emissions from this large number of individual sources still constitute only a relatively small quantity of VOC emissions. Therefore, the need for a compliance documentation method that would reduce enforcement effort is apparent. By reducing initial compliance documentation requirements, enforcement officials can devote more time and attention to the verification of continuing compliance.

This report provides a compilation of manufacturers' recommendations of combinations of adsorbers and perc drycleaning equipment that should comply with RACT regulations. Properly

sized carbon adsorption systems have been shown to meet the 100-ppm emission limit easily. The recommended combinations, however, may have to be adjusted based on source testing of the various configurations. It has not been determined whether refrigeration and scrubbing systems are equivalent to carbon adsorption. This report, therefore, deals primarily with carbon adsorbers as the retrofit control.

A tabular presentation of data for each carbon adsorber is given in Appendix A. Appendix B gives more information on refrigeration systems and scrubbers.

SECTION 2

DRYCLEANING PROCESS DESCRIPTION

The perc drycleaning process consists of three basic steps: washing, extraction, and drying. Clothes are washed in one of two types of machines, characterized as transfer or dry-to-dry machines. The transfer machines currently being manufactured carry out the washing and extraction steps. Clothes are then transferred to the dryer. The dry-to-dry machines perform all three steps.

The washing step may include one or two solvent baths, although most commercial cleaners use only one. The use of a two-bath system generally improves overall cleaning efficiency. As an aid in removing water-soluble soils, small amounts of detergent (and sometimes water) are added to the solvent in the one-bath system.

In the extraction step in both machines, the solvent bath is drained; then the clothes are spun at a high speed to wring out excess solvent. Most of the newer transfer machines are washer-extractor types; thus the washing and extraction steps are the same as in the dry-to-dry machines.

After the extraction step the procedure differs with the two types of machines. With the transfer machines an operator transfers clothes to the dryer-reclaimer. Current OSHA regulations require that perc-laden air be drawn away from the operator when clothes are being transferred from the washer-extractor to the dryer. This is accomplished by an exhaust fan, which pulls air into the washer and dryer doors and away from the operator when the doors are open.

All perc plants use a solvent-reclaiming dryer. Heated air is blown over the clothes in a closed, recirculating loop to vaporize the solvent, which is then recovered in a water-cooled condenser. After a timed drying step (usually 15 to 20 minutes), fresh air is blown over the clothes for approximately 5 minutes to complete the drying cycle and aerate the clothes. During this aeration portion of the drying cycle, the airstream and perc vapors are to be vented to a carbon adsorption system.

During the washing cycle, perc is passed through a filter for removal of suspended matter and dyes. The filter may be either a paper cartridge type or a regenerative type. The paper cartridge filter, usually containing some activated carbon for removal of dyes, is re-used for several wash cycles and is drained before it is discarded. The regenerative filter is regenerated by backwashing the filter powder precoat and adding a new precoat. The backwash contains diatomaceous earth, activated carbon, suspended matter removed from the perc, and a considerable amount of perc that must be recovered. Perc recovery is usually accomplished in a muck cooker, which is a distillation unit with direct steam injection.

Removal of nonvolatile residues, such as oils and fats, from the perc is accomplished in a unit that distills the perc from the impurities, which are discarded as still bottoms. Periodic distillation of all or part of the solvent is necessary to prevent buildup of these soluble impurities.

COIN-OPERATED DRYCLEANING ESTABLISHMENTS

Coin-ops are distinguished from the commercial and industrial drycleaners in that the drycleaning equipment is activated by the customer. Often the manager or attendant of the coin-op assists the customer in drycleaning the clothes. Coin-ops provide a low cost, self-service type of drycleaning without pressing, spotting, or other services provided by commercial drycleaners.

The drycleaning units used in typical coin-ops are dry-to-dry machines. The units use cartridge filters; no distillation of the perc is performed at a typical coin-op.

Cartridge filters being marketed for coin-ops include a fluted paper cartridge with or without a core consisting of activated carbon, activated carbon and clay, or carbon. Activated carbon adsorbs the dyes from the perc and the clay adsorbs nonvolatile residues.

COMMERCIAL DRYCLEANING ESTABLISHMENTS

Commercial drycleaners include small, independent neighborhood shops, franchised shops, and specialty shops that clean leather and other fine goods. Commercial drycleaners generally use transfer equipment. To date, the dry-to-dry machine has been used very little in commercial perc plants because machine utilization is only half that of the transfer machine, which allows simultaneous use of the washer and dryer. Interest in the dry-to-dry machine is increasing, however, because it can

meet OSHA regulations more easily and requires less attention during the cleaning cycle than the transfer type. Furthermore, the equipment manufacturers are increasing their efforts to improve and sell this type. Presently, about 25 percent of the commercial plants have dry-to-dry machines.

A typical commercial perc plant would have one washer-extractor of 25- to 50-lb capacity, one or two reclaiming dryers of equivalent size, a solvent filter with disposable paper cartridges, and a distillation unit.

INDUSTRIAL DRYCLEANING ESTABLISHMENTS

Industrial launderers with drycleaning facilities are engaged primarily in supplying laundered or drycleaned work uniforms, wiping towels, safety equipment, dust control items, and other selected items to industrial or commercial users. These items may belong to the industrial launderers and be supplied to the users on a rental basis, or they may belong to customers.

Work uniforms and executive shirts and slacks are usually drycleaned because longer wear is achieved by drycleaning than by laundering, and the aggressive action of the solvents toward heavily greased items often produces superior results. Laundering, with water and detergent, is nonetheless indispensable in the removal of water-solubles such as perspiration odors. Some launderers commonly use a dual-phase cleaning process consisting of an initial water wash followed by a solvent wash and rinse.

A typical industrial system is a transfer type, consisting of a 250-lb washer/extractor and a matching reclaiming dryer. Multibath washing is common; that is, the items to be cleaned are subjected to a water and detergent wash, a solvent wash, and a solvent rinse. Solvent filtration is seldom used. Suspended matter and nonvolatile residues are removed by distillation. The residue from distillation is further treated in a muck cooker for removal of solvent.

SECTION 3

CONTROL TECHNOLOGY AND INITIAL COMPLIANCE FACTORS

DISCUSSION OF RACT REGULATIONS

Model regulations for perc drycleaning facilities based on RACT were issued in September 1979. They specify that the owner or operator must accomplish the following:

- Vent the dryer exhaust through a carbon adsorption system or equally effective control device and emit no more than 100 ppm of VOC's from the dryer control device before dilution.
- Immediately repair all components found to be leaking liquid VOC.
- Cook or treat diatomaceous earth filters so that the residue contains 25 percent VOC or less.
- Reduce VOC from all solvent stills to 60 percent or less from wet waste material.
- Drain all filtration cartridges in their housing for at least 24 hours before discarding and, when possible, dry all drained cartridges without emitting VOC to the atmosphere.

Facilities exempt from the provisions pertaining to carbon adsorption and the associated 100-ppm limit are coin-operated facilities, facilities where an adsorber cannot be accommodated because of inadequate space, or facilities with insufficient steam capacity to desorb adsorbers.

For an owner or operator subject to the carbon adsorption provision and the attendant 100-ppm VOC limit, final compliance is to be achieved by January 1, 1982. If the control equipment cannot be delivered prior to November 1, 1981, and the owner or operator placed the order prior to January 1, 1981, the final compliance date will be 60 days after delivery of the equipment. An owner or operator subject to the maintenance provisions of the regulations must comply by January 1, 1981. The owner or operator may also submit a proposed alternative compliance schedule subject to approval by EPA.

Visual inspection will be the means of determining compliance with the provisions requiring the owner or operator to vent the dryer exhaust through a control device, to drain filtration cartridges in the filter housing for at least 24 hours before discarding, and when possible, to dry all drained cartridges without emitting VOC to the atmosphere. The following components will be visually inspected to determine compliance:

Hose connections, unions, couplings, and valves
Machine door gasket and seating
Filter head gasket and seating
Pumps
Base tanks and storage containers
Water separators
Filter sludge recovery
Distillation unit
Divertor valves
Saturated lint from lint basket
Cartridge filters

All components found to be leaking liquid VOC must be repaired immediately.

The procedure described by the American National Standards Institute[3] will be used to determine compliance with the requirements for diatomaceous earth filter residues (25 g or less VOC per 100 kg of wet waste material) and solvent still residues (60 kg or less VOC per 100 kg of wet waste material).

Compliance with the 100-ppm emission limit from the dryer control device before dilution is to be determined by either a test consistent with EPA Test Method 23[2] or by verification of the proper installation, operation, and maintenance of equipment which has been demonstrated to be adequate to meet the emission limit. The discussion accompanying EPA's model regulation states that the carbon adsorbers tested have achieved much better control than 100 ppm at the outlet. The EPA further states that the vendors should be able to demonstrate that their equipment, if properly installed and operated, will be adequate to meet the emission limits. Proper maintenance of a carbon adsorber could provide compliance at a given facility on the basis of proven performance elsewhere. Hence, the EPA has established the precedent of equipment equivalency, which is recognized as a viable alternative to individual source testing. Nonetheless, the EPA has not totally abandoned source testing for the drycleaning industry and views it as a tool that can be used when deemed appropriate on a case-by-case basis.

FACTORS AFFECTING INITIAL COMPLIANCE

The perc emission limit of 100 ppm in the dryer exhaust from perc drycleaning systems can be easily achieved by venting to an adequately designed and properly operated activated carbon adsorption system. In several EPA tests of these systems, the outlet perc concentrations were well below 100 ppm.

The activated carbon used in perc adsorbers is made from either bituminous coal or petroleum coke. The particle size is in the four- to ten-mesh range with oversize and undersize fractions not more than 5 percent each. This carbon is used extensively for solvent vapor adsorption and air purification. Solvents treated include benzene, toluene, and xylene, as well as perc. The carbon is readily regenerated by steam stripping. Its working adsorptive capacity for perc is about 20 percent of the weight of the carbon. Hence, a 100-kg carbon bed should adsorb about 20 kg of perc.

The chief factor affecting compliance is the proper sizing of the carbon bed. Tests by the EPA have shown that 3 to 6 lb of perc per 100 lb of clothes remain in the clothes after drying and before the beginning of the aeration. Hence, the carbon must adsorb this amount of perc to prevent violation of the 100-ppm emission limit. Because a carbon bed will hold 20 percent of its own weight in perc, only a limited number of aeration cycles can be accommodated before breakthrough occurs.

Other factors that may influence initial compliance are:

Insufficient adsorptive capacity of activated carbon because of manufacturing defects. Inadequate adsorptive capacity can be detected by noting the amount of perc desorbed in the first few cycles and comparing with the expected value.

Leakage in the air recirculation circuit because of lint accumulation and damaged gaskets on isolation dampers.

Excursions in temperature and concentration of perc in the airstream to the carbon adsorber.

Variations in humidity of the airstream. In general, water vapor decreases the adsorptive capacity of carbon for perc. Thus breakthrough occurs sooner at high relative humidities.

SECTION 4

COMPENDIUM OF CARBON ADSORBER MANUFACTURERS' RECOMMENDATIONS OF ADSORBER/DRYCLEANING MACHINE CONFIGURATIONS

Regulatory agencies should verify compliance on a preliminary basis by affirming that the control system has been installed properly and that the carbon beds are being regenerated on a schedule that is compatible with the specific configuration of drycleaning machines/control system. In the absence of a rigorous preliminary inspection that is equivalent to a source test, some noncomplying systems undoubtedly will slip through. It is believed, however, that reducing the enforcement efforts to determine initial compliance will allow greater emphasis on enforcement efforts to determine continuing compliance, and any noncomplying sources should be discovered.

EQUIPMENT SURVEY

In design of a method for documenting initial compliance in the perc drycleaning industry, it is necessary to determine the available types and capacities of drycleaning equipment and carbon adsorption systems. Such an equipment survey then serves as a basis for determining the compatibility of the various drycleaning units and control systems.

Drycleaning Equipment

Nine companies are currently producing perc drycleaning reclaimers or dry-to-dry machines that vent either to a control device or to the atmosphere during aeration. Table 1 shows these companies and the sizes and types of equipment they sell. A French machine, Frimair, is to be marketed in the United States in mid-1980. This machine, however, is a 25-lb dry-to-dry unit that does not vent to the atmosphere during the aeration phase.

Carbon Adsorber Equipment

Only six firms currently offer carbon adsorbers for sale to drycleaning plants. Their products are listed in Table 2. Carbon adsorbers by Hoyt Manufacturing Corp. and Vic Manufacturing Co. are manufactured in the United States. American Permac

TABLE 1

MANUFACTURERS AND DRYCLEANING EQUIPMENT

Manufacturer/Vendor	Machine sizes, lb of clothes	
	Reclaiming dryers	Dry-to-dry machines
American Laundry Machinery, Inc.	50,250	
American Permac, Inc.		20, 30, 40, 70, 140, 240, 330
Detrex Chemical Industries, Inc.		30, 40, 55, 80, 100
The Dexter Company		8
Hoyt Manufacturing Corp.	35, 50, 80	
Multimatic Corp.		25, 35, 45, 85, 90, 140, 280, 330
Spencer America, Inc.		25, 40, 60, 100, 110, 150, 165, 330
Vic Manufacturing Company	85	40, 50, 65, 140
Wascomat of America		15, 25, 30, 45, 75, 100, 150, 300

TABLE 2

ACTIVATED CARBON ADSORBERS FOR DRYCLEANING ESTABLISHMENTS

Manufacturer and model	Carbon weight, lb	Perc capacity, lb	Air flow, cfm	Regen. time, minutes	Cleaning capacity, lb of clothes per regeneration cycle	
					Mfr. rating	EPA estimate[a]
Wascomat						
100	44	7	176	60	270	117
150	66	10	282	60	425	167
240	104	17	371	60	680	283
400	170	28	565	60	1200	467
900	275	45	777	60	2300	750
1300	364	60	1130	60	2860	1000
1800	507	82	1590	60	3520	1367
3000	838	148	2296	60	6380	2467
Spencer American						
SS80	80	16	180	15	165	N/A[b]
750[c]	220	43	750	30	300	717
1000[c]	280	59	1000	30	500	983
1500[c]	440	86	1500	30	700	1433
Vic						
128	130	24	600	45	300	400
118	300	56	600	45	400	933
108[c]	300	56	600	45	400	933
American Permac[d]						
A51	46	10	212	45	275	167
A60	99	20	282	45	525	333
A80	154	46	424	45	925	767
A125	551	110	1342	60	2650	1833
A100[e]	551	110	1342	60	1000	1833

(continued)

TABLE 2 (continued)

Manufacturer and model	Carbon weight, lb	Perc capacity, lb	Air flow, cfm	Regen. time, minutes	Cleaning capacity, lb of clothes per regeneration cycle	
					Mfr. rating	EPA estimate[a]
Hoyt						
1	110	20.9	N/A[b]	60	300	348
4	205	41.0	N/A[b]	60	600	683
8[c]	350	70.0	N/A[b]	60	900	1167
12[c]	420	83.5	N/A[b]	60	1200	1392
AVRS-15	420	83.5	N/A[b]	60	1200	1392
American Laundry Machinery						
Ajax Prof.[f]	300	56.0	600	N/A[b]	N/A[b]	933

[a] Based on 6 lb of perc per 100 lb of clothes.
[b] Not available.
[c] Dual-bed unit; parameters given are for each adsorber bed.
[d] Multiple-bed option available on models A51, A60, A80, and A125.
[e] The A100 is recommended only for use with PERMAC cleaning equipment.
[f] This unit has a condenser in front of the adsorber, which should increase the amount of clothes cleaned between regenerations.

equipment is manufactured in West Germany, Spencer American in England, and Wasco-Clean in Italy. American Laundry Machinery of Cincinnati, Ohio, plans to enter the market soon and is now distributing sales brochures. Marvel Manufacturing of San Antonio, Texas, has a unit in the design phase.

These carbon adsorbers are all compatible with standard drycleaning equipment. Appropriate ductwork must be installed to connect the dryer and washer vents with the adsorption unit. Capacities have been defined in terms of weight of carbon in the unit, perc adsorption capacity, airflow rates, and estimated pounds of clothes cleaned before desorption.

The rated capacity to adsorb perc is about 20 percent of the weight of carbon in the adsorber, but there is no correlation between the weight of carbon in the adsorber and the manufacturer's recommendations of the quantity of clothes that can be cleaned between carbon regeneration cycles. The time between regenerations depends upon the size of each bed, the number of carbon beds in a multiple-bed system relative to the given drycleaning machine size, temperature of the cooling water to the condenser, and perc content of the clothes.

Beds of activated carbon suitable for use in adsorption of perc vapors from drycleaning operations are designed according to the following criteria:

Space velocities of the order of 100 reciprocal minutes. Space velocity is defined as the ratio of volumetric flow of treated gas to volume of bed.

A ratio of volumetric flow rate to bed cross-sectional area of about 328 m^3 per minute per m^2 of cross sectional area (100 ft^3 per minute per ft^2).

A bed working capacity of about 20 percent, which is the weight of perchloroethylene adsorbed (and also amenable to desorption) as a percentage of the total weight of activated carbon.

Carbon bed depths range from 0.23 to 0.81 m (9 to 32 in.). The volumetric gas flow vented to the carbon bed during aeration is usually about 0.25 dry standard cubic meter per minute per kg of clothes dried (4 dscfm per lb). Temperatures of the bed inlet and outlet gas are about 43°C and 24°C (110°F and 75°F) respectively. Moisture contents are usually near 1 percent.

The adsorbed perc may be desorbed with steam at the rate of about 4 kg steam per kg of perc to be desorbed.

COMPATIBILITY OF ADSORBERS WITH VARIOUS DRYCLEANING MACHINES

For initial compliance the most important factor is the amount of perc to be adsorbed during each aeration phase. For comparison of the available carbon adsorbers, a common basis must be chosen. Tests by the EPA have shown that clothes contain 3 to 6 percent perc by weight after drying and before aeration. For this compilation of recommended adsorber/drycleaning machine combinations it is assumed that clothes will contain 6 percent perc by weight and that the carbon adsorber must adsorb this quantity without breakthrough. It is also assumed that the maximum perc capacity for each carbon bed is 20 percent of the carbon weight. This factor should ensure that the 100-ppm outlet concentration limit will not be exceeded.

Drycleaning systems that vent door fan exhausts, floor pickups, perc/water separators, or other units to the carbon adsorber might reach saturation sooner than a drycleaning system that vents only the aeration flow to the bed. These flows, however, are usually short in duration or low in perc concentration, and the emission factor of 6 lb perc per 100 lb clothes should be high enough to account for this small additional perc load on the adsorber.

Factors such as defective carbon, lint accumulation and leakage around damaged gaskets, humidity, and temperature excursions will not be addressed for the initial compliance guidance. Quality assurance procedures for the manufacture of activated carbon should prevent significant numbers of carbon beds from containing defective carbon. Proper operation and maintenance of drycleaning equipment should also prevent lint accumulation, damaged gaskets, and temperature excursions. High humidity (above 50 percent) decreases the adsorptive capacity of the carbon for perc. At humidities below 50 percent, water vapor does not affect the carbon bed. High humidity is not be a significant factor for most drycleaning facilities.

For each bed of the carbon adsorber, it is possible to estimate for each capacity of drycleaning machine the number of aeration cycles before regeneration is required, based on the 6-lb perc/100-lb clothes emission factor and the 20 percent adsorption capacity of the carbon bed. This information is depicted in Figures 1 through 4 for the commonly found configurations. Each graph shows the number of aeration cycles that can be vented to the carbon bed for each drycleaning machine/control system configuration without exceeding the 100-ppm emission limit. The suitable combinations may have to be adjusted based on source testing of various configurations. For dual- or multiple-bed units, it is necessary to contact the adsorber manufacturer to obtain specific information on how these units should be operated and with which drycleaning machines they are compatible.

As an example, assume a drycleaner has a 30 lb reclaimer or dry-to-dry machine and cleans 10 loads of clothes per day. From Table 1, the suitable carbon adsorbers that allow regeneration of the carbon bed at the end of the day are the American Permac A60, the Hoyt 1, the Wasco Clean 400, the VIC 128, and the VIC 118. For a drycleaner having the same size machine but cleaning 14 loads per day, the suitable carbon adsorbers that allow regeneration of the carbon bed at the end of the day are the Wasco Clean 400, the Hoyt 4, and the VIC 118. Larger carbon adsorbers, depicted in Figures 2 through 4, are also compatible with a 30 lb reclaimer or dry-to-dry machine. They would probably not be the economical choice, however.

A tabular presentation of the data for each carbon adsorber is given in Appendix A; the tables show relationships of dry-cleaning machine capacities (10 to 400 lb clothes per load) and number of aeration cycles (1 to 20).

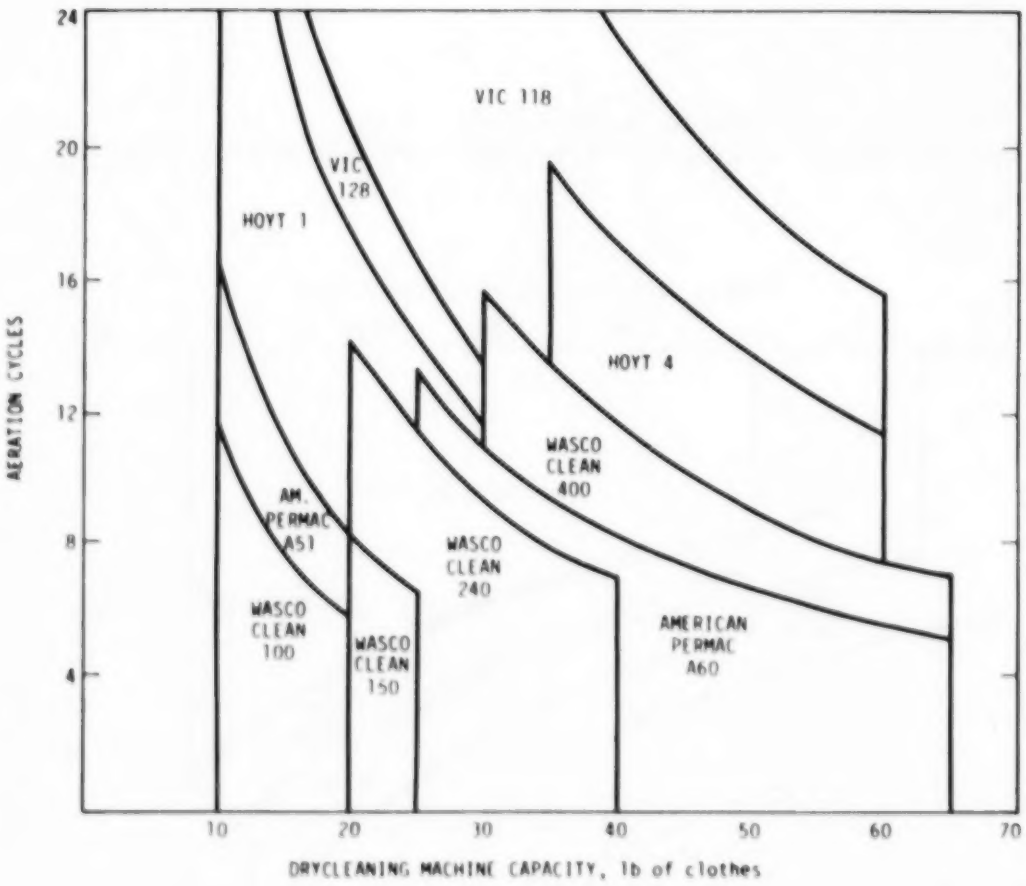

Figure 1. Carbon adsorbers compatible with various drycleaning machines, 10 to 65 lb clothes capacity.

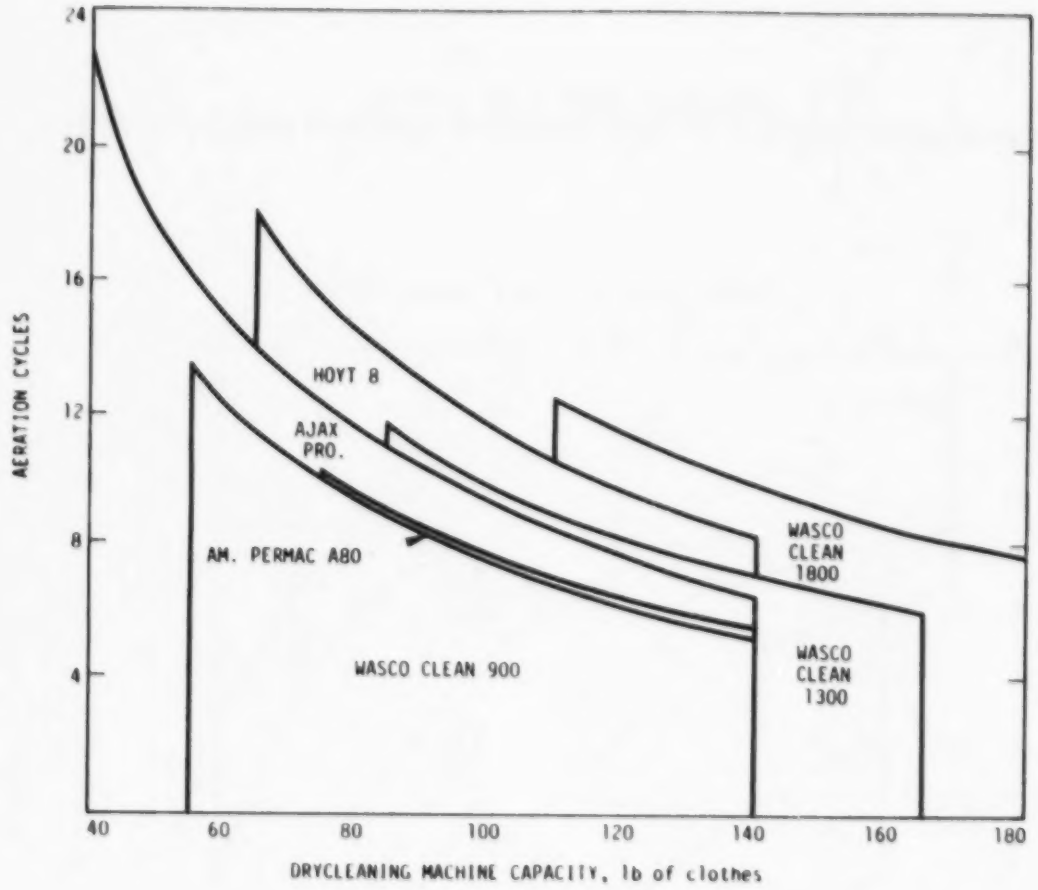

Figure 2. Carbon adsorbers compatible with various drycleaning machines, 40 to 165 lb clothes capacity.

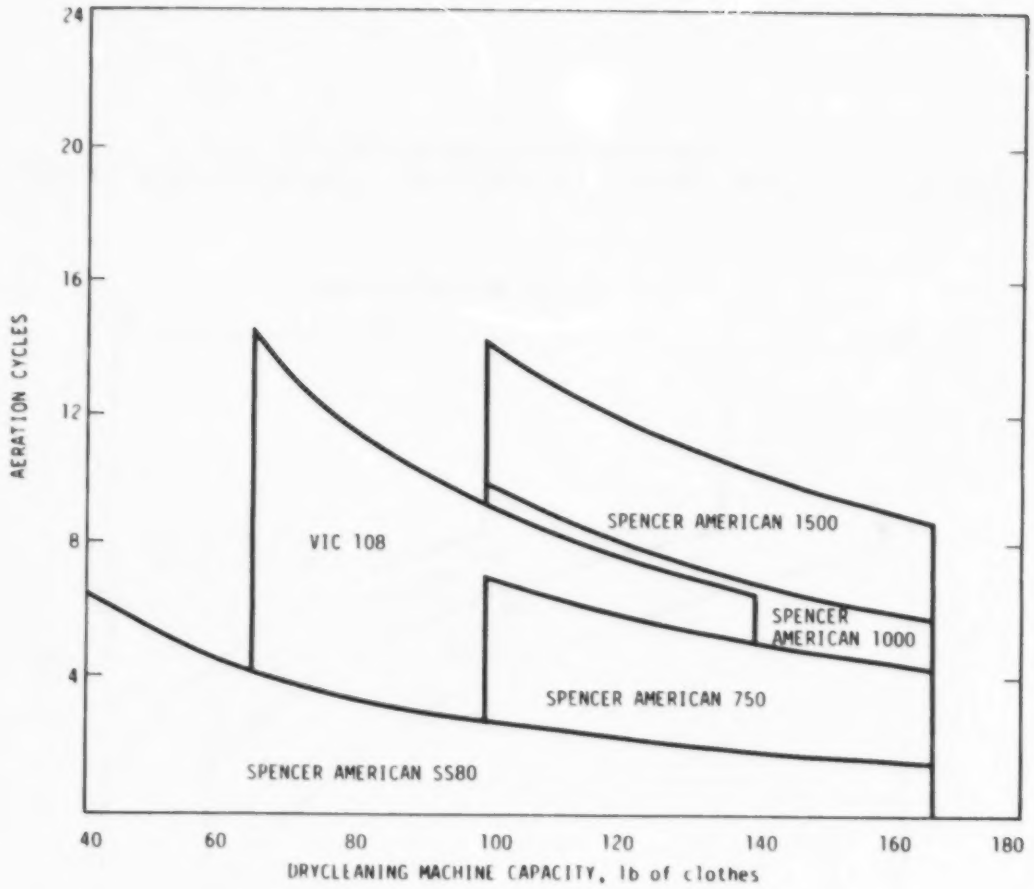

Figure 3. Carbon adsorbers compatible with various drycleaning machines, 40 to 165 lb clothes capacity.

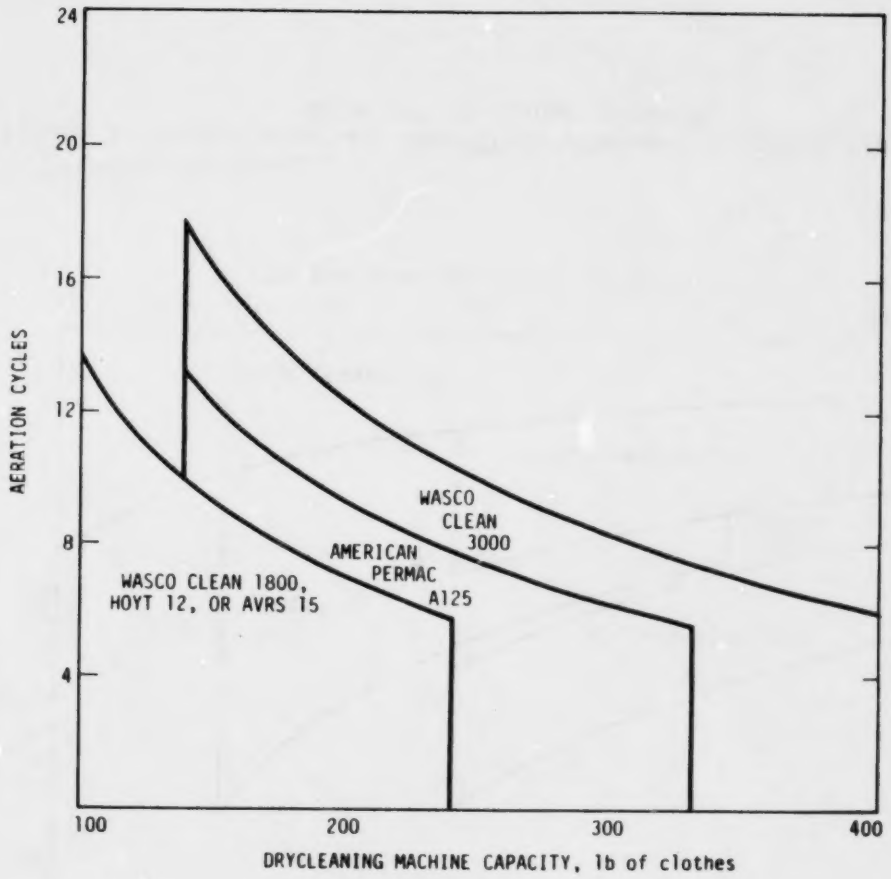

Figure 4. Carbon adsorbers compatible with various drycleaning machines, 100 to 400 lb clothes capacity.

REFERENCES

1. U.S. Environmental Protection Agency. Control of Volatile Organic Emissions from Perchloroethylene Dry Cleaning Systems. EPA-450/2-78-050, December 1978. 49 p.

2. U.S. Environmental Protection Agency. Measurement of Volatile Organic Compounds. EPA-450/2-78-041. September 1979. 60 p.

3. American National Standards Institute. Method of Test for Dilution of Gasoline Engine Crankcase Oils. ANSI/ASTM D322-67, 1972.

APPENDIX A

CAPACITIES OF DRYCLEANING MACHINES COMPATIBLE WITH AVAILABLE CARBON ADSORBERS

Tables A-1 through A-26 show the capacities of drycleaning machines that are suitable for use with each of the currently available commercial carbon adsorbers. Where the combination of adsorber and drycleaning machine is operable for the indicated number of aeration cycles, an "X" is shown in the table. Combinations that are recommended by the adsorber manufacturer are enclosed in dashed lines on each table.

The American Permac A100 is not shown in the graphs because the unit is suitable for use only on Permac drycleaning machines of 140 to 330 lb capacity.

TABLE A-1

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE WITH THE WASCO CLEAN 100

Carbon bed capacity from EPA emission factor - 117 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X			
15	X	X	X	X	X	X					
20	X	X	X	X	X						

TABLE A-2

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE
WITH THE WASCO CLEAN 150

Carbon bed capacity from EPA emission factor - 167 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	
15	X	X	X	X	X	X	X	X			
20	X	X	X	X	X	X	X				
25	X	X	X	X	X	X					

TABLE A-3

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE WITH THE WASCO CLEAN 240

Carbon bed capacity from EPA emission factor - 283 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	
20	X	X	X	X	X	X	X	X	X		
25	X	X	X	X	X	X	X	X			
30	X	X	X	X	X	X	X				
35	X	X	X	X	X	X	X				
40	X	X	X	X	X	X					

TABLE A-4

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE WITH THE WASCO CLEAN 400

Carbon bed capacity from EPA emission factor - 467 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	
30	X	X	X	X	X	X	X	X	X	X	
35	X	X	X	X	X	X	X	X	X		
40	X	X	X	X	X	X	X	X			
45	X	X	X	X	X	X	X	X			
50	X	X	X	X	X	X	X				
55	X	X	X	X	X	X	X				
60	X	X	X	X	X	X					
65	X	X	X	X	X	X					

TABLE A-5

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE
WITH THE WASCO CLEAN 900

Carbon bed capacity from EPA emission factor - 750 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	
45	X	X	X	X	X	X	X	X	X	X	
50	X	X	X	X	X	X	X	X	X	X	
55	X	X	X	X	X	X	X	X	X		
60	X	X	X	X	X	X	X	X	X		
65	X	X	X	X	X	X	X	X			
75	X	X	X	X	X	X	X	X			
85	X	X	X	X	X	X	X				
100	X	X	X	X	X	X					
120	X	X	X	X	X	X					

TABLE A-6

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE WITH THE WASCO CLEAN 1300

Carbon bed capacity from EPA emission factor - 1000 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X	X
55	X	X	X	X	X	X	X	X	X	X	X
60	X	X	X	X	X	X	X	X	X	X	
65	X	X	X	X	X	X	X	X	X	X	
75	X	X	X	X	X	X	X	X	X		
85	X	X	X	X	X	X	X	X			
100	X	X	X	X	X	X	X	X			
120	X	X	X	X	X	X	X				
140	X	X	X	X	X	X					
165	X	X	X	X	X	X					

TABLE A-7

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE WITH THE WASCO CLEAN 1800

Carbon bed capacity from EPA emission factor - 1367 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X	X
55	X	X	X	X	X	X	X	X	X	X	X
60	X	X	X	X	X	X	X	X	X	X	X
65	X	X	X	X	X	X	X	X	X	X	X
75	X	X	X	X	X	X	X	X	X	X	
85	X	X	X	X	X	X	X	X	X	X	
100	X	X	X	X	X	X	X	X	X		
120	X	X	X	X	X	X	X	X			
140	X	X	X	X	X	X	X				
165	X	X	X	X	X	X	X				
200	X	X	X	X	X	X					

TABLE A-8

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE
WITH THE WASCO CLEAN 3000

Carbon bed capacity from EPA emission factor - 2467 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X	X
55	X	X	X	X	X	X	X	X	X	X	X
60	X	X	X	X	X	X	X	X	X	X	X
65	X	X	X	X	X	X	X	X	X	X	X
75	X	X	X	X	X	X	X	X	X	X	X
85	X	X	X	X	X	X	X	X	X	X	X
100	X	X	X	X	X	X	X	X	X	X	X
120	X	X	X	X	X	X	X	X	X	X	X
140	X	X	X	X	X	X	X	X	X	X	
165	X	X	X	X	X	X	X	X	X		
200	X	X	X	X	X	X	X	X	X		
250	X	X	X	X	X	X	X				
300	X	X	X	X	X	X	X				
350	X	X	X	X	X	X					

TABLE A-9

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE
WITH THE SPENCER AMERICAN SS80

Carbon bed capacity from EPA emission factor - 267 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	
20	X	X	X	X	X	X	X	X	X		
25	X	X	X	X	X	X	X	X			
30	X	X	X	X	X	X	X				
35	X	X	X	X	X	X					
40	X	X	X	X	X	X					
45	X	X	X	X	X						
50	X	X	X	X	X						
55	X	X	X	X							
60	X	X	X	X							
65	X	X	X	X							
75	X	X	X								
85	X	X	X								
100	X	X									
120	X	X									
140	X										
165	X										

TABLE A-10

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE
WITH THE SPENCER AMERICAN 750

Carbon bed capacity from EPA emission factor - 717 pounds clothes
Regeneration time 30 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	
45	X	X	X	X	X	X	X	X	X	X	
50	X	X	X	X	X	X	X	X	X		
55	X	X	X	X	X	X	X	X	X		
60	X	X	X	X	X	X	X	X			
65	X	X	X	X	X	X	X	X			
75	X	X	X	X	X	X	X				
85	X	X	X	X	X	X	X				
100	X	X	X	X	X	X					
120	X	X	X	X	X						
140	X	X	X	X	X						
165	X	X	X	X							

TABLE A-11

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE
WITH THE SPENCER AMERICAN 1000

Carbon bed capacity from EPA emission factor - 983 pounds clothes
Regeneration time 30 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X	
55	X	X	X	X	X	X	X	X	X	X	
60	X	X	X	X	X	X	X	X	X	X	
65	X	X	X	X	X	X	X	X	X	X	
75	X	X	X	X	X	X	X	X	X		
85	X	X	X	X	X	X	X	X			
100	X	X	X	X	X	X	X				
120	X	X	X	X	X	X	X				
140	X	X	X	X	X	X					
165	X	X	X	X	X						

TABLE A-12

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE WITH THE SPENCER AMERICAN 1500

Carbon bed capacity from EPA emission factor - 1433 pounds clothes
Regeneration time 30 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X	X
55	X	X	X	X	X	X	X	X	X	X	X
60	X	X	X	X	X	X	X	X	X	X	X
65	X	X	X	X	X	X	X	X	X	X	X
75	X	X	X	X	X	X	X	X	X	X	
85	X	X	X	X	X	X	X	X	X	X	
100	X	X	X	X	X	X	X	X	X		
120	X	X	X	X	X	X	X	X			
140	X	X	X	X	X	X	X	X			
165	X	X	X	X	X	X	X				

TABLE A-13

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE WITH THE VIC 128

Carbon bed capacity from EPA emission factor - 400 pounds clothes
Regeneration time 45 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	
30	X	X	X	X	X	X	X	X	X		

TABLE A-14

CAPACITIES OF DRYCLEANING MACHINES SUITABLE
FOR USE WITH VIC 118

Carbon bed capacity from EPA emission factor - 933 pounds clothes
Regeneration time 45 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X	
55	X	X	X	X	X	X	X	X	X	X	
60	X	X	X	X	X	X	X	X	X	X	

TABLE A-15

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE WITH VIC 108 (Double Bed)

Carbon bed capacity from EPA emission factor - 933 pounds clothes
Regeneration time 45 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X	
55	X	X	X	X	X	X	X	X	X	X	
60	X	X	X	X	X	X	X	X	X	X	
65	X	X	X	X	X	X	X	X	X		
75	X	X	X	X	X	X	X	X	X		
85	X	X	X	X	X	X	X	X			
100	X	X	X	X	X	X	X				
120	X	X	X	X	X	X					
140	X	X	X	X	X	X					

TABLE A-16

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE WITH THE AMERICAN PERMAC A51

Carbon bed capacity from EPA emission factor - 167 pounds clothes
Regeneration time 45 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	
15	X	X	X	X	X	X	X	X			
20	X	X	X	X	X	X	X				

TABLE A-17

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE WITH THE AMERICAN PERMAC A60

Carbon bed capacity from EPA emission factor - 333 pounds clothes
Regeneration time 45 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	
25	X	X	X	X	X	X	X	X	X		
30	X	X	X	X	X	X	X	X			
35	X	X	X	X	X	X	X				
40	X	X	X	X	X	X	X				
45	X	X	X	X	X	X					
50	X	X	X	X	X	X					
55	X	X	X	X	X	X					
60	X	X	X	X	X						
65	X	X	X	X	X						

TABLE A-18

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE WITH THE AMERICAN PERMAC A80

Carbon bed capacity from EPA emission factor - 767 pounds clothes
Regeneration time 45 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	
45	X	X	X	X	X	X	X	X	X	X	
50	X	X	X	X	X	X	X	X	X	X	
55	X	X	X	X	X	X	X	X	X		
60	X	X	X	X	X	X	X	X	X		
65	X	X	X	X	X	X	X	X			
75	X	X	X	X	X	X	X	X			
85	X	X	X	X	X	X	X				
100	X	X	X	X	X	X					
120	X	X	X	X	X	X					

TABLE A-19

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE WITH THE AMERICAN PERMAC A125

Carbon bed capacity from EPA emission factor - 1833 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X	X
55	X	X	X	X	X	X	X	X	X	X	X
60	X	X	X	X	X	X	X	X	X	X	X
65	X	X	X	X	X	X	X	X	X	X	X
75	X	X	X	X	X	X	X	X	X	X	X
85	X	X	X	X	X	X	X	X	X	X	X
100	X	X	X	X	X	X	X	X	X	X	
120	X	X	X	X	X	X	X	X	X	X	
140	X	X	X	X	X	X	X	X	X		
165	X	X	X	X	X	X	X	X			
200	X	X	X	X	X	X	X				
250	X	X	X	X	X	X					
300	X	X	X	X	X	X					

TABLE A-20

CAPACITIES OF DRYCLEANING MACHINES SUITABLE FOR USE
WITH THE AMERICAN PERMAC A100
(SUITABLE FOR USE ON PERMAC CLEANING MACHINES ONLY)

Carbon bed capacity from EPA emission factor - 1833 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X	X
55	X	X	X	X	X	X	X	X	X	X	X
60	X	X	X	X	X	X	X	X	X	X	X
65	X	X	X	X	X	X	X	X	X	X	X
75	X	X	X	X	X	X	X	X	X	X	X
85	X	X	X	X	X	X	X	X	X	X	X
100	X	X	X	X	X	X	X	X	X	X	
120	X	X	X	X	X	X	X	X	X	X	
140	X	X	X	X	X	X	X	X	X		
165	X	X	X	X	X	X	X	X			
200	X	X	X	X	X	X	X				
250	X	X	X	X	X	X					
300	X	X	X	X	X	X					

TABLE A-21

CAPACITIES OF DRYCLEANING MACHINES SUITABLE
FOR USE WITH THE HOYT 1

Carbon bed capacity from EPA emission factor - 348 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	
25	X	X	X	X	X	X	X	X	X		
30	X	X	X	X	X	X	X	X			

TABLE A-22

CAPACITIES OF DRYCLEANING MACHINES SUITABLE
FOR USE WITH THE HOYT 4

Carbon bed capacity from EPA emission factor - 683 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	
40	X	X	X	X	X	X	X	X	X	X	
45	X	X	X	X	X	X	X	X	X	X	
50	X	X	X	X	X	X	X	X	X		
55	X	X	X	X	X	X	X	X	X		
60	X	X	X	X	X	X	X	X			

TABLE A-23

CAPACITIES OF DRYCLEANING MACHINES SUITABLE
FOR USE WITH THE HOYT 8

Carbon bed capacity from EPA emission factor - 1167 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X	X
55	X	X	X	X	X	X	X	X	X	X	X
60	X	X	X	X	X	X	X	X	X	X	
65	X	X	X	X	X	X	X	X	X	X	
75	X	X	X	X	X	X	X	X	X	X	
85	X	X	X	X	X	X	X	X	X		
100	X	X	X	X	X	X	X	X			
120	X	X	X	X	X	X	X				

TABLE A-24

CAPACITIES OF DRYCLEANING MACHINES SUITABLE
FOR USE WITH THE HOYT 12

Carbon bed capacity from EPA emission factor - 1392 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X	X
55	X	X	X	X	X	X	X	X	X	X	X
60	X	X	X	X	X	X	X	X	X	X	X
65	X	X	X	X	X	X	X	X	X	X	X
75	X	X	X	X	X	X	X	X	X	X	
85	X	X	X	X	X	X	X	X	X	X	
100	X	X	X	X	X	X	X	X	X		
120	X	X	X	X	X	X	X	X			
140	X	X	X	X	X	X	X				
165	X	X	X	X	X	X	X				
200	X	X	X	X	X	X					

TABLE A-25

CAPACITIES OF DRYCLEANING MACHINES SUITABLE
FOR USE WITH THE AVRS 15

Carbon bed capacity from EPA emission factor - 1392 pounds clothes
Regeneration time 60 minutes

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X	X
55	X	X	X	X	X	X	X	X	X	X	X
60	X	X	X	X	X	X	X	X	X	X	X
65	X	X	X	X	X	X	X	X	X	X	X
75	X	X	X	X	X	X	X	X	X	X	
85	X	X	X	X	X	X	X	X	X	X	
100	X	X	X	X	X	X	X	X	X		
120	X	X	X	X	X	X	X	X			
140	X	X	X	X	X	X	X				
165	X	X	X	X	X	X	X				
200	X	X	X	X	X	X					

TABLE A-26

CAPACITIES OF DRYCLEANING MACHINES SUITABLE
FOR USE WITH THE AJAX PROFESSIONAL

Carbon bed capacity from EPA emission factor - 933 pounds clothes
Regeneration time not available

Capacity of drycleaning machines, pounds	Number of cleaning machine cycles before regeneration becomes necessary (X = suitable for use)										
	1	2	3	4	5	6	8	10	12	15	20
10	X	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X	
55	X	X	X	X	X	X	X	X	X	X	
60	X	X	X	X	X	X	X	X	X	X	
65	X	X	X	X	X	X	X	X	X		
75	X	X	X	X	X	X	X	X	X		
85	X	X	X	X	X	X	X	X			
100	X	X	X	X	X	X	X				
120	X	X	X	X	X	X					
140	X	X	X	X	X	X					

APPENDIX B

OTHER CONTROL SYSTEMS FOR PERCHLOROETHYLENE DRYCLEANERS

Regulations regarding emissions from the dryer permit the use of control systems that are equivalent in performance to activated carbon adsorption systems. A number of refrigeration and scrubbing systems on the market are claimed by the manufacturers to be equivalent to carbon adsorption. In operation, they differ from activated carbon systems in that the air is recirculated during the aeration or deodorization phase of the cleaning cycle. In contrast, the deodorization air is vented once through in carbon adsorption.

Spencer America, Inc., of St. Louis, Missouri, offers a refrigeration system that can be installed on drycleaning machines with capacities up to 70 lb. Solvent-laden aeration air is ducted to a "cold storage system" consisting of a bed of stones through which refrigerant coils (-25°F) are distributed. Solvent condenses and drips into the separator below the bed. Airflow is downward through the bed. Exit air from the bed is recycled to the drycleaning machine. A column of liquid solvent below the bed acts as a seal to prevent the return air from leaking through the separator. Air recirculation takes place throughout the aeration cycle (3 to 5 minutes), and additional makeup air is not required.

Kleen-Rite, Inc., also of St. Louis, offers two refrigeration systems. The first one, known as KR II, is for drycleaning machines of 10 to 60 lb capacity. The second system, KR III, is for drycleaning machines between 60 and 140 lb. During both drying and aeration, the air passes over finned-tube refrigerated condensers that have a skin temperature of 20°F. Kleen-Rite claims 75 to 95 percent capture of the perc normally vented during aeration.

Multimatic Corporation of Palisades Park, New Jersey, offers a 35-lb dry-to-dry Shop Star machine tnat has refrigerative emission control equipment. The control equipment recirculates air during the aeration cycle. Solvent is scrubbed from the airstream by refrigerated ethylene glycol (temperature below 0°C), and the glycol is separated from the perc. Cumulative

adsorption of water vapor by the glycol reduces its effectiveness so that the glycol has to be replaced every four to six months. The scrubbed air is reheated to 135°F and recycled for aeration.

Diversitron Corporation of Fresh Meadows, New York, offers patented control systems that are made in England. Air is recirculated during the aeration phase. Vapor-laden air passes through a scrubber consisting of screens and baffles. The screens are submerged in water. Air bubbles are formed and mass transfer of perc occurs from the bubbles to the water.

The primary driving force for mass transfer appears to be formation of an "azeotrope" between perc and water. The temperature at which scrubbing occurs is 16°C. Air exhausted after aeration was reported to contain 5 to 90 ppm perc.

The control system is manufactured in three standard sizes to fit drycleaning machines with capacities up to 125 lb. Devices for higher capacity machines are custom built by the company.

Because the equivalency of these systems has not been adequately demonstrated, the initial compliance documentation method only describes carbon adsorption systems.